

**AMENDMENT & RESPONSE UNDER 37 C.F.R. § 1.116 - EXPEDITED PROCEDURE**

Serial Number: 09/132,157

Filing Date: August 11, 1998

Title: SILICON-GERMANIUM DEVICES FOR CMOS FORMED BY ION IMPLANTATION AND SOLID PHASE EPITAXIAL REGROWTH

Page 4  
Dkt: 303.229US2**REMARKS**

Applicant has carefully reviewed and considered the Office Action mailed on September 25, 2001, and the references cited therewith.

Claims 11, 24, 25, 28, 38, 40, and 41 are amended, no claims are canceled, and no claims are added; as a result, claims 11, 13, 14, 24-28, 32, and 38-43 are now pending in this application.

**§102 Rejection of the Claims**

Claims 11, 14, 24, 28, 38, and 40 were rejected under 35 USC § 102(b) as being anticipated by Selvakumar et al. (U.S. Pat. No. 5,426,069). Claims 25, 32, and 41 were rejected under 35 USC § 102(b) as being anticipated by, or in the alternative under 35 USC § 103(a) as obvious over Selvakumar et al. (U.S. Pat. No. 5,426,069).

The pending Office Action states (on page 4, third paragraph, among other locations) that the SiGe region of Selvakumar “is not separated from the SiO<sub>2</sub> gate oxide layer by a layer of silicon.” If there is no separation layer of silicon between the SiGe region and the SiO<sub>2</sub> gate oxide layer, then Applicant respectfully submits that the particular process utilized by Selvakumar inherently will produce germanium oxide along with silicon dioxide (SiO<sub>2</sub>) when forming the gate oxide layer of Selvakumar.

The process of forming the gate oxide in Selvakumar is described in Col. 3, lines 40-68, and in Col. 4, lines 1-3. The description in Selvakumar appears to include first implanting germanium through an exposed window (Col. 3, lines 41-44), then forming a dry gate oxide (Col 3, lines 45-48). Forming the dry oxide is further described as being performed at 1100° C for 50 minutes in dry oxygen and a 20 minute nitrogen anneal. The Selvakumar process of oxidizing the channel region to form the gate oxide after the germanium is already implanted will necessarily form germanium oxides along with SiO<sub>2</sub> if the germanium is exposed as suggested by the pending Office Action.

In contrast, Applicant’s unique process implants the germanium after the gate oxide has been formed. The implant of germanium atoms in Applicant’s process is directed through the gate oxide, and forms a Si<sub>1-x</sub>Ge<sub>x</sub> channel region and a continuous Si<sub>1-x</sub>Ge<sub>x</sub>/SiO<sub>2</sub> gate oxide interface. No oxidation steps are performed in Applicant’s process subsequent to the germanium

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being introduced to the channel region.

The process of Applicant's invention therefore leads to a unique structure implied by the process recited in the claims. No germanium oxide will be formed at the  $\text{Si}_{1-x}\text{Ge}_x/\text{SiO}_2$  gate oxide interface formed in Applicant's invention because the germanium in Applicant's process is never exposed to an oxidation step. Germanium oxides are undesirable because they are not stable, as discussed on page 2, lines 16-19 of Applicant's specification.

Pursuant to MPEP 2113, product-by-process claims are limited by the structure implied by the steps. Applicant respectfully submits that the claims as amended provide structure that is patentable over Selvakumar. Because Selvakumar does not include all elements of Applicant's independent claims 11, 24, 25, 28, 38, 40, and 41, the reference does not support a 35 USC § 102(b) rejection. Reconsideration and withdrawal of the 35 USC § 102(b) rejection is therefore respectfully requested with respect to independent claims 11, 24, 25, 28, 38, 40, and 41 and all claims that depend therefrom.

**§103 Rejection of the Claims**

Claims 13, 26, 27, 39, 42, and 43 were rejected under 35 USC § 103(a) as being unpatentable over Selvakumar et al. (U.S. Pat. No. 5,426,069) in view of Crabbe et al. (U.S. Pat. No. 5,821,577).

Crabbe appears to show a transistor containing a silicon germanium channel 18. However, the silicon germanium layer in Crabbe is "sandwiched between layers of pure silicon" (Col. 4, ln. 45-48). As further discussed in col. 6, ln. 22-28, a silicon cap layer 20 is deposited on the SiGe channel layer 18, and a gate insulator layer 22 is formed on the cap layer 20. Crabbe does not show or suggest a  $\text{Si}_{1-x}\text{Ge}_x$  channel region, having a germanium molar fraction x, located underneath the  $\text{SiO}_2$  gate oxide and between the source/drain regions, wherein x is less than or equal to 0.6, and wherein the  $\text{Si}_{1-x}\text{Ge}_x$  channel region forms a continuous  $\text{Si}_{1-x}\text{Ge}_x/\text{SiO}_2$  gate oxide interface.

In contrast, all independent claims of Applicant's invention include a  $\text{Si}_{1-x}\text{Ge}_x$  channel region, having a germanium molar fraction x, located underneath the  $\text{SiO}_2$  gate oxide and between the source/drain regions, wherein x is less than or equal to 0.6, and wherein the  $\text{Si}_{1-x}\text{Ge}_x$  channel region forms a continuous  $\text{Si}_{1-x}\text{Ge}_x/\text{SiO}_2$  gate oxide interface wherein no germanium

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oxide is present at the  $\text{Si}_{1-x}\text{Ge}_x/\text{SiO}_2$  gate oxide interface as a result of ion implantation of germanium through the previously formed  $\text{SiO}_2$  gate oxide.

Because Crabbe fails to cure the deficiencies of Selvakumar, a 35 USC § 103 is not supported by the listed references. Reconsideration and withdrawal of Examiner's 35 USC § 103(a) rejection is therefore respectfully requested with respect to claims 13, 26, 27, 39, 42, and 43.

**CONCLUSION**

Applicant respectfully submits that the claims are in condition for allowance and notification to that effect is earnestly requested. The Examiner is invited to telephone Applicant's attorney at (612) 373-6944 to facilitate prosecution of this application.

If necessary, please charge any additional fees or credit overpayment to Deposit Account No. 19-0743.

Respectfully submitted,

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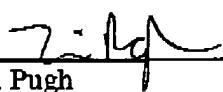


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I hereby certify that this paper is being transmitted by facsimile to the U.S. Patent and Trademark Office on the date shown below.

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